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Kumar

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(54) **POWER-EFFICIENT CONTROL OF DISPLAY DATA CONFIGURED TO BE RENDERED ON A DISPLAY UNIT OF A DATA PROCESSING DEVICE**

(71) Applicant: **NVIDIA Corporation**, Santa Clara, CA (US)

(72) Inventor: **Harsha Kumar**, Maharashtra (IN)

(73) Assignee: **NVIDIA Corporation**, Santa Clara, CA (US)

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G09G 5/14	(2006.01)
G09G 3/34	(2006.01)

(52) **U.S. Cl.**

CPC ***G09G 5/14*** (2013.01); ***G09G 3/342*** (2013.01); *G09G 2320/0686* (2013.01); *G09G 2330/021* (2013.01)

(58) **Field of Classification Search**

CPC G09G 5/00

See application file for complete search history.

(56) **References Cited**

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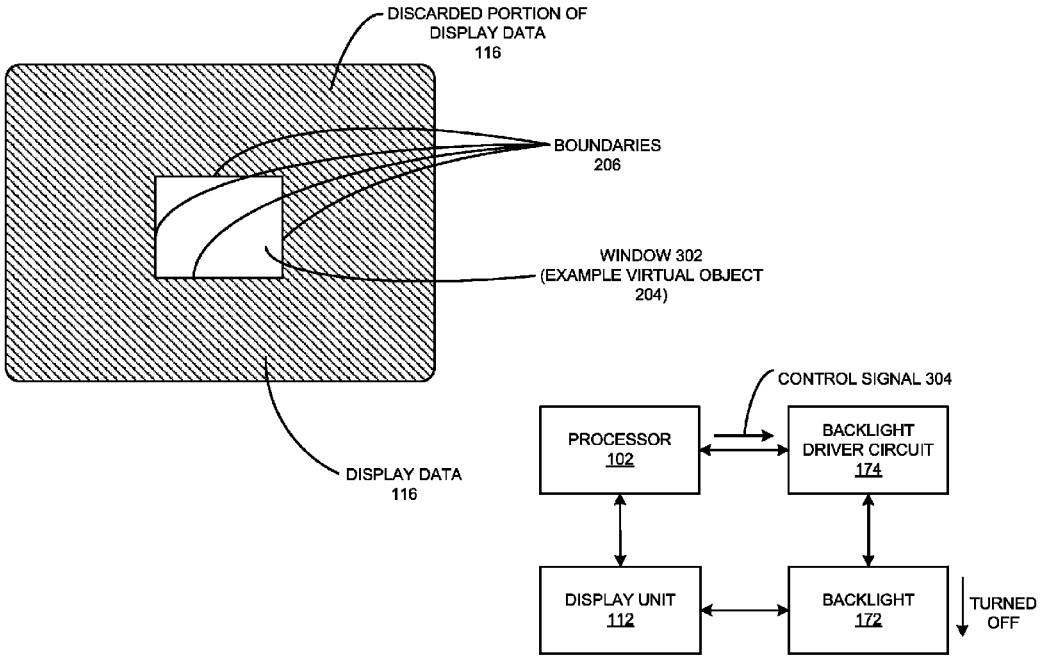
Primary Examiner — Michael Faragalla

(74) *Attorney, Agent, or Firm* — Zilka-Kotab, PC

(57) **ABSTRACT**

A method includes scanning, through a processor of a data processing device communicatively coupled to a memory, display data to be rendered on a display unit communicatively coupled to the data processing device for boundaries of one or more virtual object(s) therein. The method also includes rendering, through the processor, a portion of the display data outside the boundaries of the one or more virtual object(s) at a reduced level compared to a portion of the display data within the boundaries on the display unit.

18 Claims, 7 Drawing Sheets



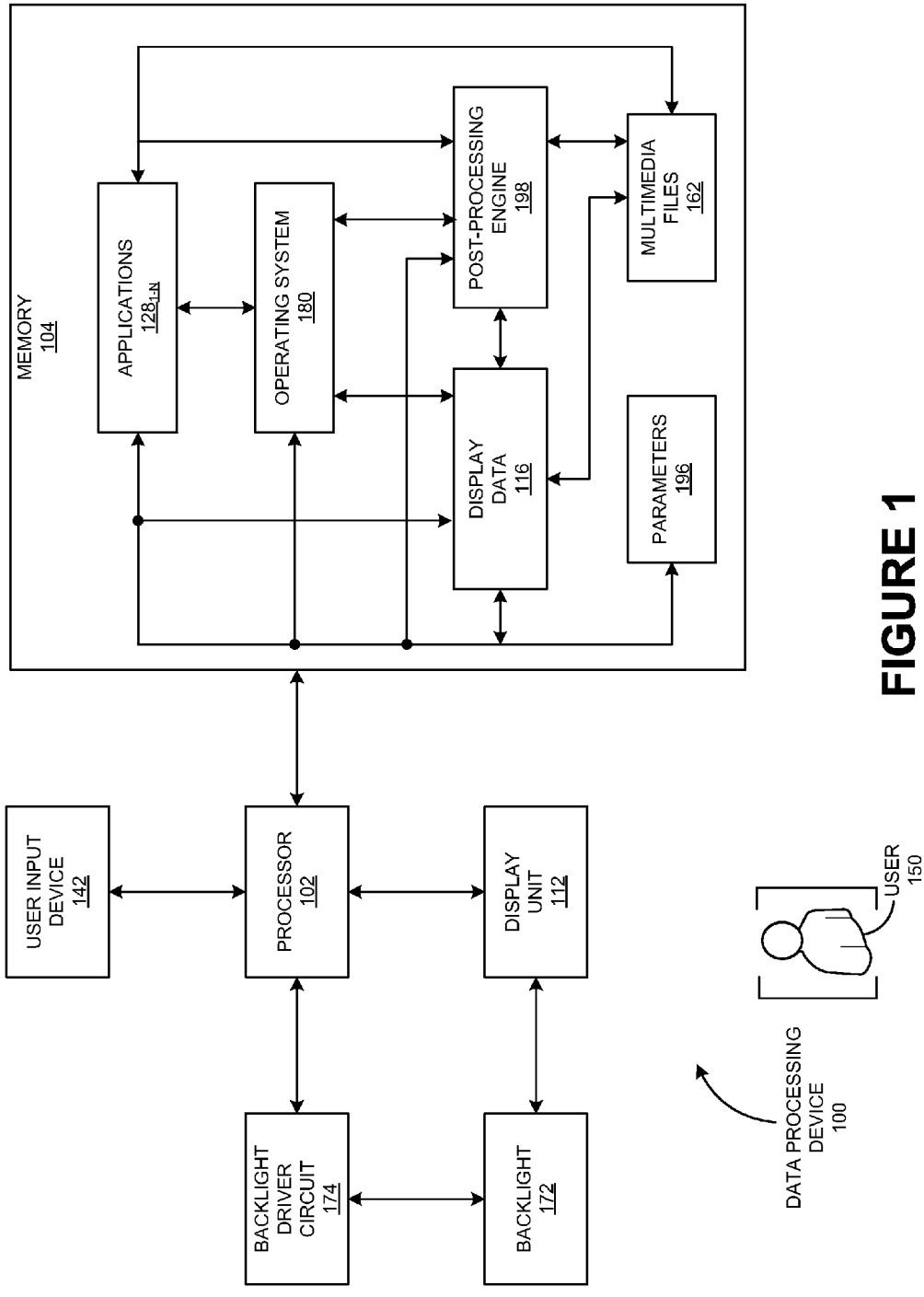

MEMORY
104
APPLICATIONS
128 1-N
OPERATING SYSTEM
180
POST-PROCESSING
ENGINE
198
MULTIMEDIA
FILES
162
DISPLAY
DATA
116
PARAMETERS
196
USER INPUT
DEVICE
142
PROCESSOR
102
DISPLAY
UNIT
112
BACKLIGHT
DRIVER
CIRCUIT
174
BACKLIGHT
172
USER
150
DATA PROCESSING
DEVICE
100

FIGURE 1

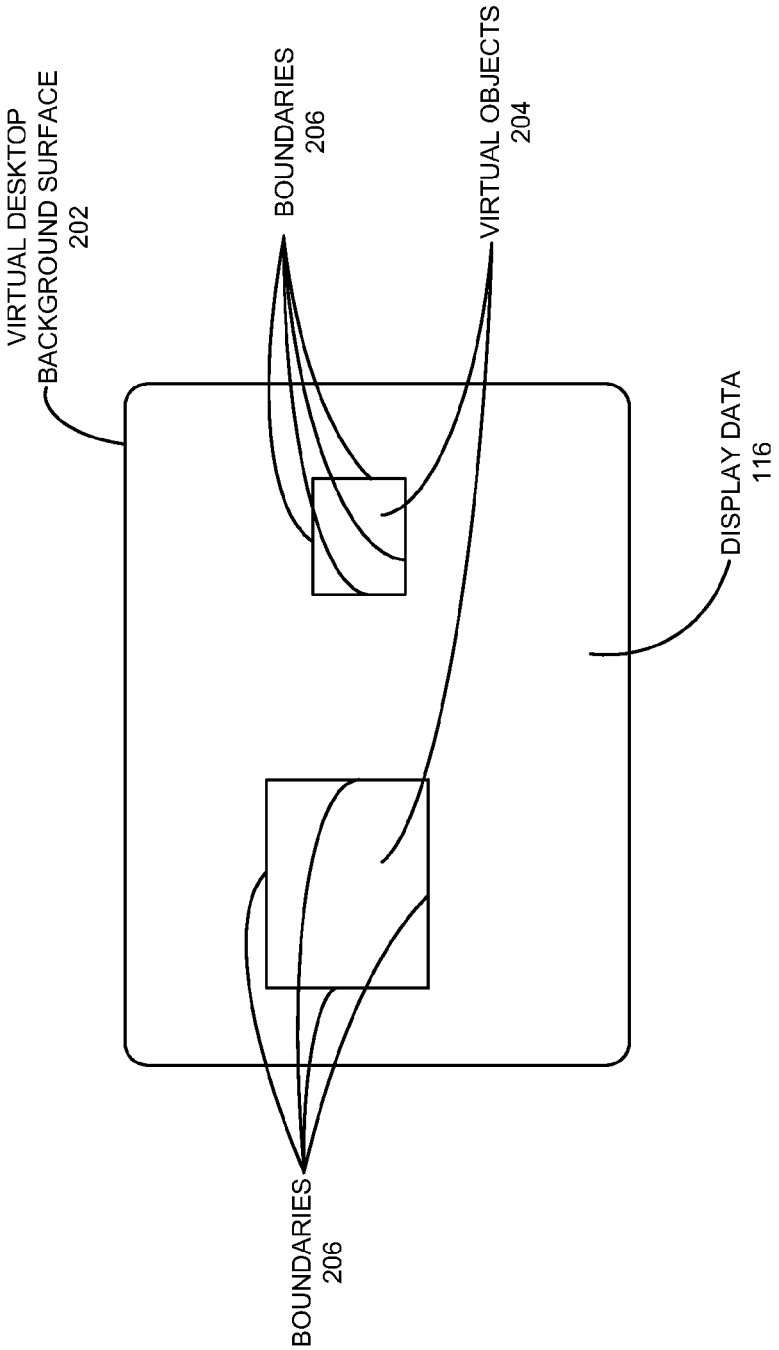

VIRTUAL DESKTOP BACKGROUND SURFACE 202
BOUNDARIES 206
VIRTUAL OBJECTS 204
DISPLAY DATA 116
BOUNDARIES 206

FIGURE 2

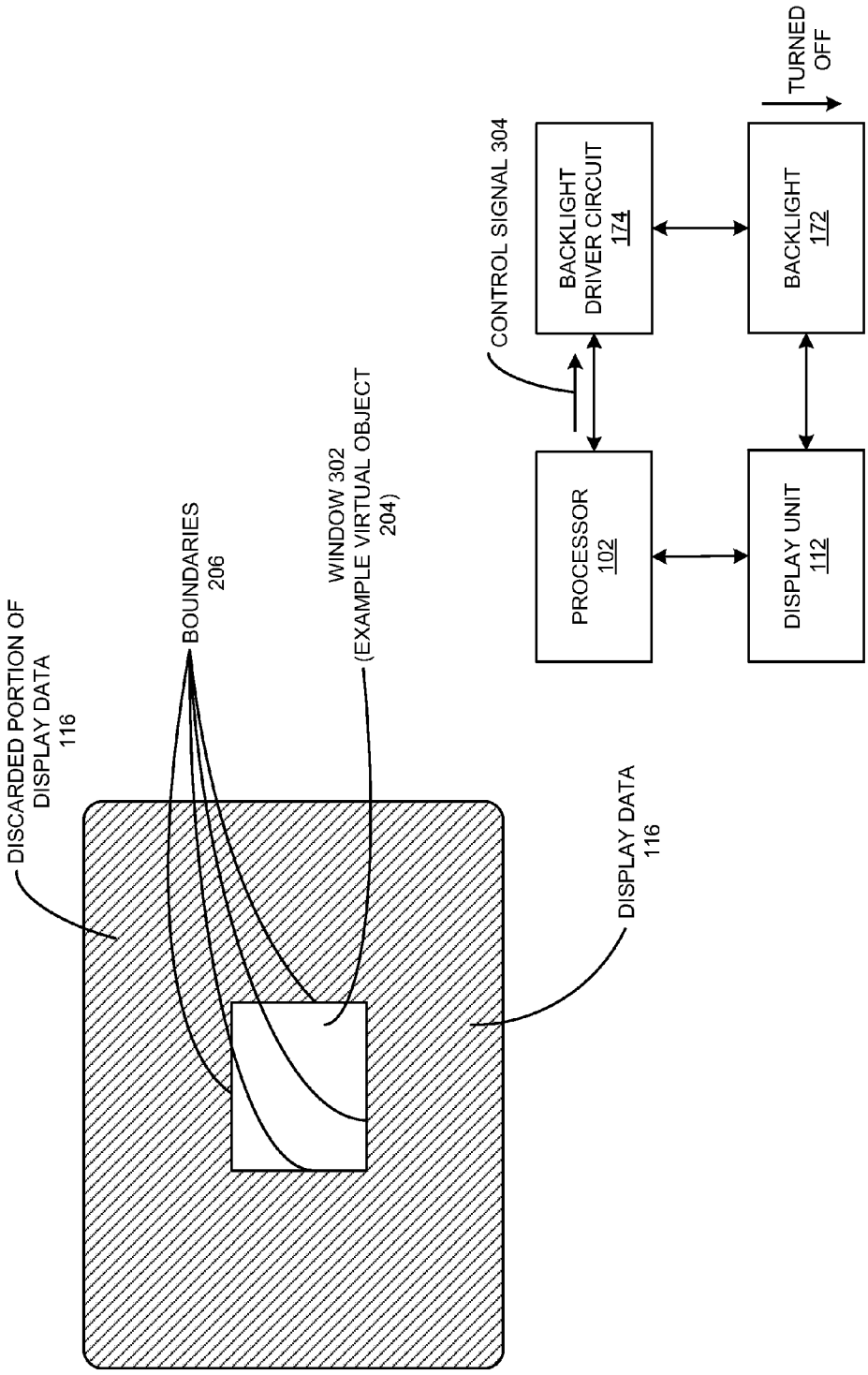

DISCARDED PORTION OF DISPLAY DATA 116
BOUNDARIES 206
WINDOW 302 (EXAMPLE VIRTUAL OBJECT 204)
DISPLAY DATA 116
CONTROL SIGNAL 304
PROCESSOR 102
DISPLAY UNIT 112
BACKLIGHT DRIVER CIRCUIT 174
BACKLIGHT 172
TURNED OFF

FIGURE 3

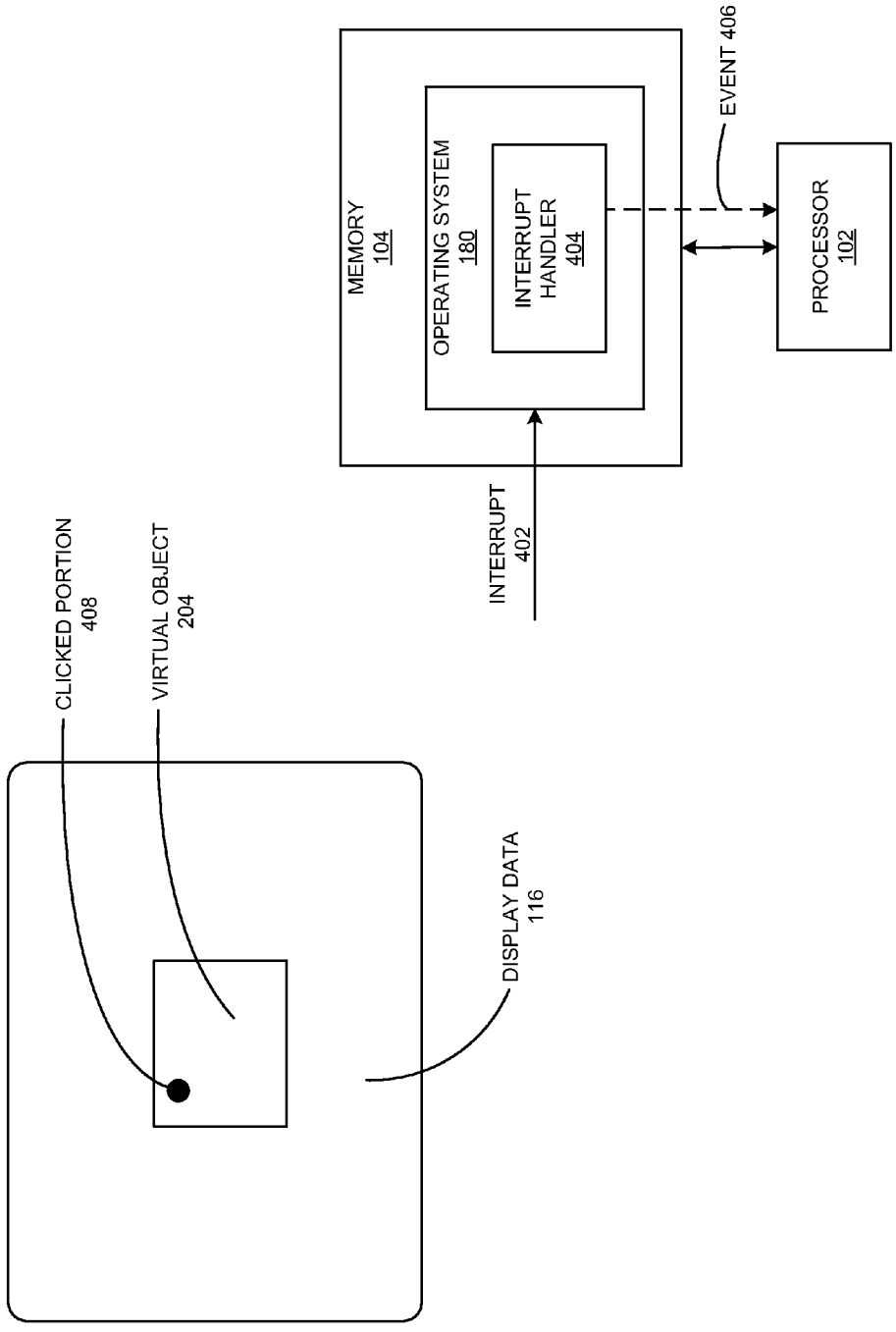

MEMORY
104
OPERATING SYSTEM
180
INTERRUPT
HANDLER
404
EVENT 406
PROCESSOR
102
INTERRUPT
402
CLICKED PORTION
408
VIRTUAL OBJECT
204
DISPLAY DATA
116

FIGURE 4

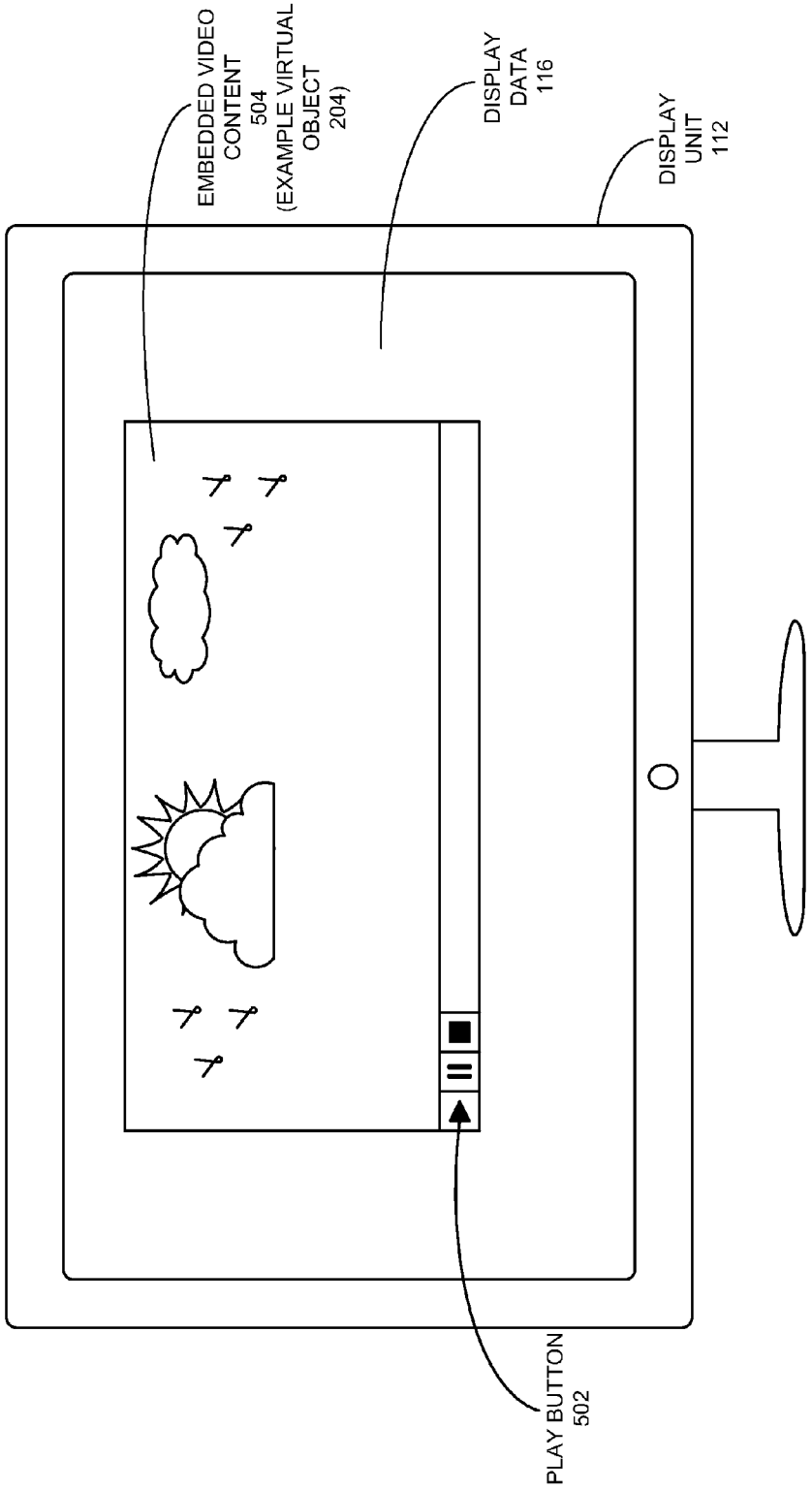

EMBEDDED VIDEO CONTENT 504 (EXAMPLE VIRTUAL OBJECT 204)
DISPLAY DATA 116
DISPLAY UNIT 112
PLAY BUTTON 502

FIGURE 5

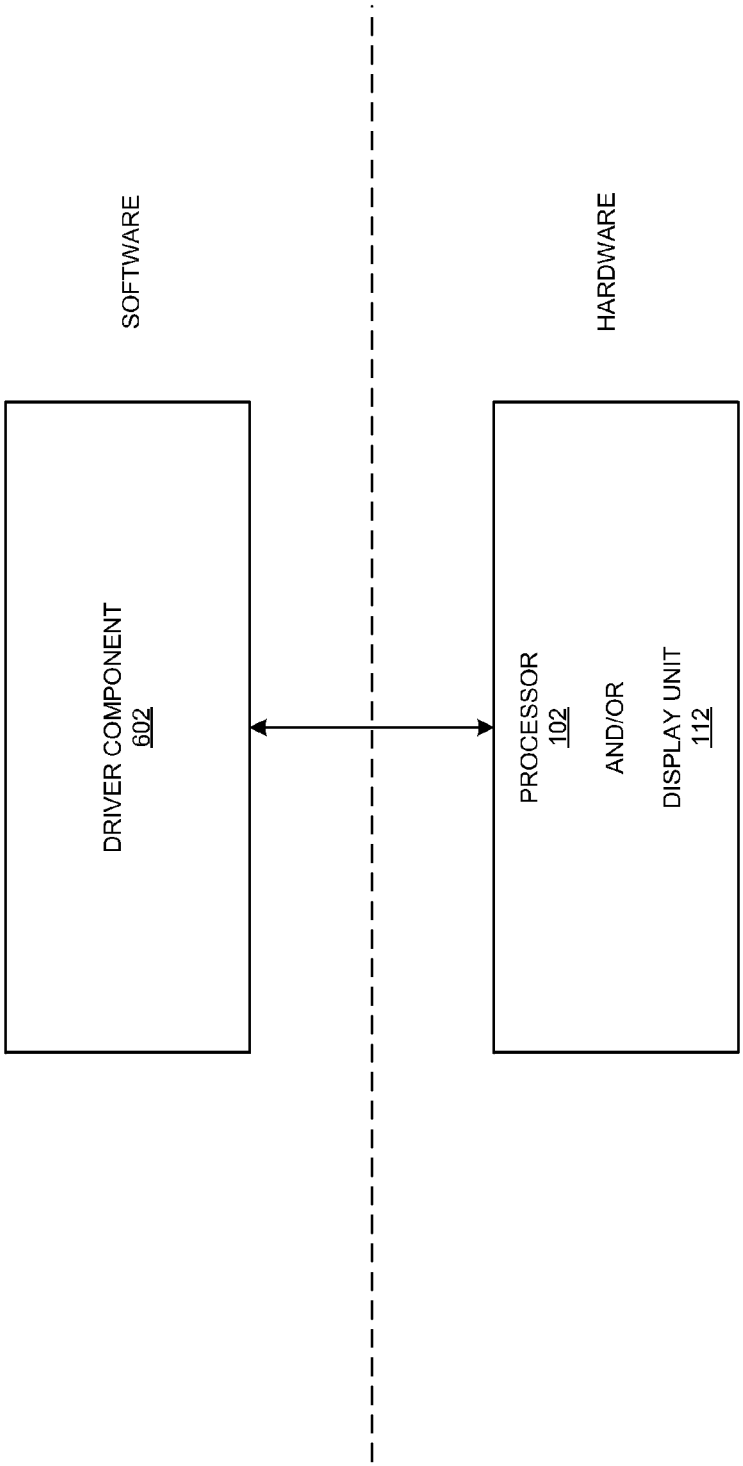

SOFTWARE
HARDWARE
DRIVER COMPONENT
602
PROCESSOR
102
AND/OR
DISPLAY UNIT
112

FIGURE 6

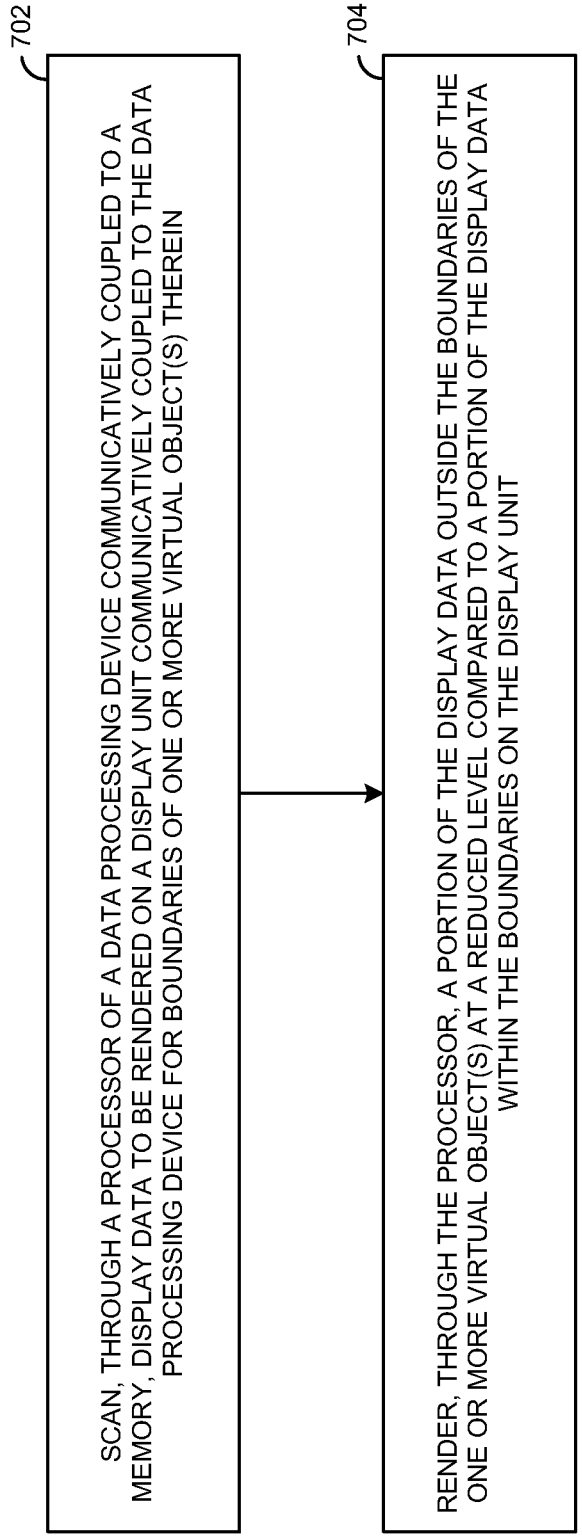

702
SCAN, THROUGH A PROCESSOR OF A DATA PROCESSING DEVICE COMMUNICATIVELY COUPLED TO A MEMORY, DISPLAY DATA TO BE RENDERED ON A DISPLAY UNIT COMMUNICATIVELY COUPLED TO THE DATA PROCESSING DEVICE FOR BOUNDARIES OF ONE OR MORE VIRTUAL OBJECT(S) THEREIN
704
RENDER, THROUGH THE PROCESSOR, A PORTION OF THE DISPLAY DATA OUTSIDE THE BOUNDARIES OF THE ONE OR MORE VIRTUAL OBJECT(S) AT A REDUCED LEVEL COMPARED TO A PORTION OF THE DISPLAY DATA WITHIN THE BOUNDARIES ON THE DISPLAY UNIT

FIGURE 7

POWER-EFFICIENT CONTROL OF DISPLAY DATA CONFIGURED TO BE RENDERED ON A DISPLAY UNIT OF A DATA PROCESSING DEVICE

FIELD OF TECHNOLOGY

This disclosure relates generally to data processing devices and, more particularly, to a method, a device and/or a system of power-efficient control of display data configured to be rendered on a display unit of a data processing device.

BACKGROUND

A data processing device (e.g., a desktop computer, a laptop computer, a notebook computer, a smart television, a smart display, a netbook, a mobile device such as a mobile phone) may render display data on a display unit (e.g., a Liquid Crystal Display (LCD)) associated therewith. The display unit and a display data processing pipeline within the data processing device may be associated with high power consumption through the data processing device. A user of the data processing device may, therefore, operate the data processing device in a power savings mode thereof, where an intensity of a backlight of the display unit is reduced. The aforementioned power savings mode may provide for poor clarity of the display data. Further, the power savings mode may still be associated with considerable power consumption.

SUMMARY

Disclosed are a method, a device and/or a system of power-efficient control of display data configured to be rendered on a display unit of a data processing device.

In one aspect, a method includes scanning, through a processor of a data processing device communicatively coupled to a memory, display data to be rendered on a display unit communicatively coupled to the data processing device for boundaries of one or more virtual object(s) therein. The method also includes rendering, through the processor, a portion of the display data outside the boundaries of the one or more virtual object(s) at a reduced level compared to a portion of the display data within the boundaries on the display unit.

In another aspect, a non-transitory medium, readable through a data processing device and including instructions embodied therein that are executable through the data processing device, is disclosed. The non-transitory medium includes instructions to scan, through a processor of the data processing device communicatively coupled to a memory, display data to be rendered on a display unit communicatively coupled to the data processing device for boundaries of one or more virtual object(s) therein. The non-transitory medium also includes instructions to render, through the processor, a portion of the display data outside the boundaries of the one or more virtual object(s) at a reduced level compared to a portion of the display data within the boundaries on the display unit.

In yet another aspect, a data processing device includes a memory, and a processor communicatively coupled to the memory. The processor is configured to execute instructions to scan display data to be rendered on a display unit communicatively coupled to the data processing device for boundaries of one or more virtual object(s) therein, and to render a portion of the display data outside the boundaries of the one or more virtual object(s) at a reduced level compared to a portion of the display data within the boundaries on the display unit.

The methods and systems disclosed herein may be implemented in any means for achieving various aspects, and may be executed in a form of a non-transitory machine-readable medium embodying a set of instructions that, when executed by a machine, cause the machine to perform any of the operations disclosed herein.

Other features will be apparent from the accompanying drawings and from the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments of this invention are illustrated by way of example and not limitation in the figures of the accompanying drawings, in which like references indicate similar elements and in which:

FIG. **1** is a schematic view of a data processing device, according to one or more embodiments.

FIG. **2** is an illustrative view of a virtual desktop background surface provided by an operating system executing on the data processing device of FIG. **1** onto which display data is overlaid.

FIG. **3** is an illustrative view of detection of a window as an example virtual object of FIG. **2** within the display data, according to one or more embodiments.

FIG. **4** is an illustrative view of a sequence of events associated with clicking a portion of the display data.

FIG. **5** is an illustrative view of an example clicked portion of the display data viewable through a display unit of the data processing device of FIG. **1**.

FIG. **6** is a schematic view of interaction between a driver component and a processor and/or the display unit of the data processing device of FIG. **1**, according to one or more embodiments.

FIG. **7** is a process flow diagram detailing the operations involved in power-efficient control of the display data configured to be rendered on the display unit of the data processing device of FIG. **1**, according to one or more embodiments.

Other features of the present embodiments will be apparent from the accompanying drawings and from the detailed description that follows.

DETAILED DESCRIPTION

Example embodiments, as described below, may be used to provide a method, a device and/or a system of power-efficient control of display data configured to be rendered on a display unit of a data processing device. Although the present embodiments have been described with reference to specific example embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the various embodiments.

FIG. **1** shows a data processing device **100**, according to one or more embodiments. In one or more embodiments, data processing device **100** may be a laptop computer, a desktop computer, a smart television, a smart display, a notebook computer, a netbook, a tablet or a mobile device such as a mobile phone. Other forms of data processing device **100** are within the scope of the exemplary embodiments discussed herein. In one or more embodiments, data processing device **100** may include a processor **102** (e.g., a Central Processing Unit (CPU), a Graphics Processing Unit (GPU)) communicatively coupled to a memory **104** (e.g., a

volatile memory and/or a non-volatile memory); memory **104** may include storage locations configured to be addressable through processor **102**.

FIG. **1** shows a display unit **112** (e.g., a Cathode Ray Tube (CRT) display, a Liquid Crystal Display (LCD)) being interfaced with processor **102**; processor **102** may be configured to generate display data **116** to be rendered on display unit **112**. FIG. **1** shows display data **116** and one or more parameter(s) **196** (e.g., pixel intensity, pixel resolution) thereof being stored in memory **104**; memory **104** may also include one or more multimedia file(s) **162** (e.g., text files, video files, audio files, image files) stored therein. In one or more embodiments, data processing device **100** may execute an operating system **180** thereon; again, FIG. **1** shows operating system **180** being stored in memory **104**. In one or more embodiments, display unit **112** may include a backlight **172** associated therewith; said backlight **172** may also include a backlight driver circuit **174** thereof, which is shown interfaced with processor **102** in FIG. **1**.

Further, in one or more embodiments, one or more application(s) $\mathbf{128}_{1\text{-}N}$ (shown as being stored in memory **104**) may execute on data processing device **100**. Examples of application(s) $\mathbf{128}_{1\text{-}N}$ may include but are not limited to media players, word processing applications, web browser applications and/or web applications. In one or more embodiments, one of the aforementioned application(s) $\mathbf{128}_{1\text{-}N}$ may be a process configured to execute on data processing device **100** to reduce power consumption associated with display data **116** and/or display unit **112**, as will be discussed below. Alternately, the process may be a post-processing engine (e.g., shown as post-processing engine **198** stored in memory **104**) configured to execute on processor **102** to provide for reduction of the aforementioned power consumption.

FIG. **2** shows a virtual desktop background surface **202** provided by operating system **180** onto which display data **116** is overlaid. Here, in one or more embodiments, display data **116** may include virtual objects **204** (e.g., desktop icons, windows, user interfaces, multimedia file(s) **162** being rendered directly or through a web browser application/web application) viewable through display unit **112**. In one or more embodiments, the spatial location of virtual objects **204** within virtual desktop background surface **202** may be defined through operating system **180**. In one or more embodiments, through the execution of the process (e.g., application $\mathbf{128}_{1\text{-}N}$ or post-processing engine **198**) discussed above, processor **102** may be configured to detect boundaries (e.g., boundaries **206** in FIG. **2**) of virtual objects **204** within virtual desktop background surface **202**, following which a level of the one or more parameter(s) **196** (e.g., pixel intensity) of display data **116** and/or an intensity of backlight **172** outside boundaries **206** may be reduced (e.g., reduced in pixel intensity, pixels discarded, backlight **172** outside boundaries **206** turned OFF).

FIG. **3** illustrates the abovementioned process. Here, a window **302** may be an example of virtual object **204**. Once processor **102** detects boundaries **206** of window **302** based on information provided through operating system **180**, processor **102** may be configured to transmit a control signal **304** to backlight driver circuit **174** to reduce the intensity of backlight **172** outside boundaries **206** and/or reduce a level of the one or more parameter(s) **196** of display data **116** corresponding to a portion thereof outside boundaries **206**. FIG. **3** shows display data **116** outside boundaries **206** being discarded and/or backlight **172** corresponding to the portion outside boundaries **206** being switched OFF.

A user **150** (see FIG. **1**) of data processing device **100** may concentrate solely on window **302** while viewing display unit **112**. Thus exemplary embodiments may provide a means to reduce power consumption in data processing device **100** through "dimming" portions of display data **116** that are "out of focus" with respect to user **150** and/or through dimming backlight **172**.

Additionally, in one or more embodiments, an application $\mathbf{128}_{1\text{-}N}$ and/or post-processing engine **198** may include instructions (e.g., configured to execute on processor **102**) to scan display data **116** and/or a web browser application (another application $\mathbf{128}_{1\text{-}N}$) for three-dimensional (3D) content therein, and then cause the dimming of display data **116** and/or backlight **172** outside the boundaries of the 3D content. In yet another example, display data **116** onscreen or within the web browser application may be scanned for video data content, based on which processor **102** may execute instructions to enable dimming of display data **116** and/or backlight **172** outside the boundaries of the video data content.

Referring back to FIG. **1**, data processing device **100** may include a user input device **142** (e.g., a keyboard, a keypad, a mouse, a trackball) associated therewith. FIG. **1** shows user input device **142** interfaced with processor **102**. In one or more embodiments, user **150** may click on (or, select) a portion of display data **116** onscreen or within a web browser application through user input device **142**. FIG. **4** illustrates a sequence of events associated with the aforementioned clicking. As shown in FIG. **4**, the clicking of the portion of display data **116** may generate an interrupt **402** to operating system **180**. Application $\mathbf{128}_{1\text{-}N}$ and/or operating system **180** may include an interrupt handler **404** to handle said interrupt **402**; FIG. **4** shows operating system **180** as including interrupt handler **404** implemented therein. Following the handling of interrupt **402**, operating system **180** may be configured to generate an event **406** interpretable through processor **102**.

In one or more embodiments, once processor **102** interprets event **406**, processor **102** may be configured to detect boundaries **206** of virtual objects **204** discussed above around the clicked portion (e.g., clicked portion **408**) of display data **116**. Thus, in one or more embodiments, the search space for processor **102** may be reduced because of the searching/scanning being conducted around clicked portion **408**.

FIG. **5** shows an example clicked portion **408** of display data **116** viewable through display unit **112**. User **150** may click a play button **502** of an embedded video content **504** within a web browser application **504**. Here, processor **102** may scan around play button **502** to determine boundaries **206** of embedded video content **504** (example virtual object **204**) in order to dim display data **116** and/or backlight **172** around embedded video content **504**. It should be noted that the dimming may proceed for a duration of video data associated with embedded video content **504**.

In another example, user **150** may click a search option from a menu associated with content within web browser application **504**. Here, processor **102** may determine clicked portion **408** and highlight the search option in contrast to other portions of display data **116**. All reasonable variations are within the scope of the exemplary embodiments discussed herein.

In yet another example, processor **102** may determine successive clicking events (e.g., event **406**). Based on the determination, processor **102** may perform a modification of virtual object **204** and boundaries **206** thereof. For example, user **150** may first click (example input) a video content,

following which user **150** may read text data below the video content based on initiation thereof through another click through user input device **142**. Now, as the region of display data **116** associated with clicked portion **408** changes, virtual object **204** and boundaries **206** thereof also may change. Processor **102** may dynamically modify the portions of display data **116** outside boundaries **206** that are to be rendered at a level lower than that of the portions within boundaries **206**. In an alternate implementation, the dimming may proceed for a default time duration (e.g., predefined) following event **406**.

In one or more embodiments, the detection of virtual objects **204** and boundaries **206** thereof and/or the dynamic modification of the one or more parameter(s) **196** of display data **116** and/or the intensity of backlight **172** may be triggered through a driver component (e.g., a set of instructions) associated with processor **102** and/or display unit **112**. In one or more embodiments, the driver component may be packaged with one or more application(s) $\mathbf{128}_{1\text{-}N}$ and/or operating system **180**. Additionally, instructions associated with the driver component and/or the one or more application(s) $\mathbf{128}_{1\text{-}N}$ may be embodied in a non-transitory medium (e.g., a Compact Disc (CD), a Digital Video Disc (DVD), a Blu-ray Disc®, a hard drive; appropriate instructions may be downloaded to the hard drive) readable through data processing device **100** and executable therethrough.

FIG. **6** shows interaction between a driver component **602** and processor **102** and/or display unit **112**, according to one or more embodiments. In one or more embodiments, as discussed above, driver component **602** may be configured to trigger, through processor **102** (based on execution of an application $\mathbf{128}_{1\text{-}N}$ and/or post-processing engine **198**), detection of boundaries **206** of one or more virtual objects **204** (it is obvious that boundaries **206** of more than one virtual object **204** may be detected) within display data **116** and/or the dynamic modification of one or more parameter (s) **196** of display data **116** outside boundaries **206** and/or the intensity of backlight **172** outside boundaries **206** such that the portions outside boundaries **206** are rendered at a reduced level compared to portions within boundaries **206**.

In one or more embodiments, the abovementioned reduction of levels outside boundaries **206** may provide for considerable power savings with regard to data processing device **100** because the display pipeline within processor **102** and/or display unit **112** is associated with high power consumption.

FIG. **7** shows a process flow diagram detailing the operations involved in a power-efficient control of display data **116**, according to one or more embodiments. In one or more embodiments, operation **702** may involve scanning, through processor **102** of data processing device **100**, display data **116** to be rendered on display unit **112** for boundaries **206** of one or more virtual object(s) **204** therein. In one or more embodiments, operation **704** may then involve rendering, through processor **102**, a portion of display data **116** outside boundaries **206** of the one or more virtual object(s) **204** at a reduced level compared to a portion of display data **116** within boundaries **206** on display unit **112**.

Although the present embodiments have been described with reference to specific example embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the various embodiments. For example, the various devices and modules described herein may be enabled and operated using hardware circuitry (e.g., CMOS based logic circuitry), firmware, software or any combination of hardware, firmware, and software (e.g., embodied in a non-transitory machine-readable medium). For example, the various electrical structures and methods may be embodied using transistors, logic gates, and electrical circuits (e.g., application specific integrated (ASIC) circuitry and/or Digital Signal Processor (DSP) circuitry).

In addition, it will be appreciated that the various operations, processes and methods disclosed herein may be embodied in a non-transitory machine-readable medium and/or a machine-accessible medium compatible with a data processing system (e.g., data processing device **100**). Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense.

What is claimed is:

1. A method comprising:

scanning, through a processor of a data processing device communicatively coupled to a memory, display data to be rendered on a display unit communicatively coupled to the data processing device for boundaries of playable video content therein;

detecting, by the processor, a command to play the video content on the display unit; and

in response to detecting the command, rendering, through the processor, a portion of the display data outside the boundaries of the video content at a reduced level compared to a portion of the display data within the boundaries on the display unit;

wherein the rendering of the portion of the display data outside the boundaries of the video content at the reduced level is performed for a duration that the video content is played on the display unit.

2. The method of claim **1**, further comprising leveraging a virtual desktop background surface on which the display data is overlaid and a definition of a spatial position of the video content within the virtual desktop background surface provided through an operating system executing on the data processing device during determination of the boundaries of the video content.

3. The method of claim **1**, wherein rendering the portion of the display data outside the boundaries at the reduced level further comprises at least one of: modifying at least one parameter associated with the display data corresponding to the portion outside the boundaries; and reducing an intensity level of a backlight of the display unit for the portion outside the boundaries.

4. The method of claim **3**, further comprising transmitting, through the processor, a control signal to a backlight driver circuit of the backlight to enable reduction of the intensity level thereof.

5. The method of claim **1**, further comprising:

triggering at least one of: the scanning of the display data and the rendering of the portion of the display data outside the boundaries at the reduced level through a driver component associated with at least one of the processor and the display unit.

6. The method of claim **5**, further comprising providing the driver component packaged with at least one of: an operating system executing on the data processing device and an application executing on the data processing device.

7. A non-transitory medium, readable through a data processing device and including instructions embodied therein that are executable through the data processing device, comprising:

instructions to scan, through a processor of the data processing device communicatively coupled to a memory, display data to be rendered on a display unit communicatively coupled to the data processing device for boundaries of playable video content therein;

detecting, by the processor, a command to play the video content on the display unit; and

instructions responsive to detecting the command to render, through the processor, a portion of the display data outside the boundaries of the video content at a reduced level compared to a portion of the display data within the boundaries on the display unit;

wherein the rendering of the portion of the display data outside the boundaries of the video content at the reduced level is performed for a duration that the video content is played on the display unit.

8. The non-transitory medium of claim **7**, further comprising instructions to leverage a virtual desktop background surface on which the display data is overlaid and a definition of a spatial position of the video content within the virtual desktop background surface provided through an operating system executing on the data processing device during determination of the boundaries of the video content.

9. The non-transitory medium of claim **7**, wherein the instructions to render the portion of the display data outside the boundaries at the reduced level further comprise instructions to at least one of: modify at least one parameter associated with the display data corresponding to the portion outside the boundaries; and reduce an intensity level of a backlight of the display unit for the portion outside the boundaries.

10. The non-transitory medium of claim **9**, further comprising instructions to transmit, through the processor, a control signal to a backlight driver circuit of the backlight to enable reduction of the intensity level thereof.

11. The non-transitory medium of claim **7**, further comprising instructions to:

trigger at least one of: the scanning of the display data and the rendering of the portion of the display data outside the boundaries at the reduced level through a driver component associated with at least one of the processor and the display unit.

12. A data processing device comprising:

a memory; and

a processor communicatively coupled to the memory, the processor being configured to execute instructions to:

scan display data to be rendered on a display unit communicatively coupled to the data processing device for boundaries of playable video content therein,

detect a command to play the video content on the display unit; and

in response to detecting the command, render a portion of the display data outside the boundaries of the video content at a reduced level compared to a portion of the display data within the boundaries on the display unit;

wherein the rendering of the portion of the display data outside the boundaries of the video content at the reduced level is performed for a duration that the video content is played on the display unit.

13. The data processing device of claim **12**, wherein the processor is further configured to execute instructions to leverage a virtual desktop background surface on which the display data is overlaid and a definition of a spatial position of the video content within the virtual desktop background surface provided through an operating system executing on the data processing device during determination of the boundaries of the video content.

14. The data processing device of claim **12**, wherein the processor is configured to render the portion of the display data outside the boundaries at the reduced level based on at least one of: modifying at least one parameter associated with the display data corresponding to the portion outside the boundaries, and reducing an intensity level of a backlight of the display unit for the portion outside the boundaries.

15. The data processing device of claim **14**, wherein the processor is further configured to execute instructions to transmit a control signal to a backlight driver circuit of the backlight to enable reduction of the intensity level thereof.

16. The data processing device of claim **12**, wherein

the data processing device further comprises a driver component associated with at least one of the processor and the display unit to trigger at least one of: the scanning of the display data and the rendering of the portion of the display data outside the boundaries at the reduced level.

17. The data processing device of claim **16**, wherein the driver component is provided packaged with at least one of: an operating system executing on the data processing device and an application executing on the data processing device.

18. The method of claim **1**, wherein the command is detected responsive to selection by a user of the data processing device of an option displayed on the display unit to play the video content.

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